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# STASIS: AN ATTITUDE TESTBED FOR HARDWARE-IN-THE-LOOP SIMULATIONS OF AUTONOMOUS GUIDANCE, NAVIGATION, AND CONTROL SYSTEMS

**Abstract**

In the last decade, we assisted to a consistent growth of the space sector, mainly fueled by the increasing employment of CubeSat technology. CubeSats have allowed to significantly reduce both manufacturing and launch costs, enabling missions to be carried on even with lower budgets. In particular, missions targeting terrestrial orbits benefitted the most from the employment of smaller satellites; conversely, the growth of the deep-space sector lagged behind, notably because of the high costs related to on-ground operations. The ERC-funded EXTREMA (Engineering Extremely Rare Events in Astrodynamics for Deep-Space Missions in Autonomy) project aims to disrupt the current paradigm for deep-space missions by enabling CubeSats with autonomous guidance, navigation, and control capabilities. To do so, it builds on three fundamental research Pillars and aims to integrate their scientific outcomes in a hardware-in-the-loop experimental facility, the Orbital Simulation Hub (OSH).

STASIS (SpacecrafT Attitude SImulation System) is an attitude testbed currently under development at the DART laboratory of Politecnico di Milano. Its goal is to faithfully reproduce the attitude dynamics of a space probe in deep space and support the hardware-in-the-loop simulations that will be carried on in the EXTREMA OSH. The system is based on an air-bearing spherical joint capable of compensating the gravitational force acting on the Earth with a supporting thin film of air, ensuring the quasi-frictionless motion of the overlying platform with three rotational degrees of freedom. On its top, STASIS hosts a FlatSat, an assembly integrating all the necessary subsystems to run the autonomous GNC algorithms developed within the EXTREMA Pillars, which performance and behavior are to be assessed.

The paper will be structured as follows: in the first part, the functionalities of STASIS will be outlined; the challenges to face in order to achieve the fulfillment of the identified requirements will be introduced, including the balancing, powering, and estimation of the platform current state. In the second part, the current status of STASIS development will be described, detailing the employed systems and algorithms and highlighting the trade-offs that ultimately led to the design choices opted for. Finally, the last part will be focused on future scenarios, highlighting how STASIS – ergo, the OSH and EXTREMA itself – could act as a game-changing technology to pave the way towards fully autonomous interplanetary missions.